C-AD

Radiation Safety Committee

Issued: January 29, 2015

Minutes of RSC Subcommittee of January 20, 2015

Subject: Review of Temporary Beam Dump at ATF and RHIC Masks for Pre-fires

Present: D. Beavis, R. Karol, C. Schaefer, K. Yip, A. Drees, M. Minty, C. Montag, K. Kusche, J. Reich, and B. van Kuik

The committee reviewed a temporary beam dump for ATF and the new RHIC masks interact with bunches that do not receive sufficient kick from the abort system to hit the beam dump.

ATF Bean Dump

K. Kusche lead the discussion[1] with a Powerpoint presentation. The experimental spectrometer and detectors are placed in beam line no. 2 and the beam is deflected to the west by the spectrometer magnet. The existing beam dump is not useful for the beam and a new one needs to be constructed to accommodate this experiment. The magnet has a power supply that is bi-polar and there may be a need to "de-Gauss" the system by operating in reverse polarity without beam. Therefore potential beam faults must be considered with the magnet in either polarity.

The experiment will routinely operate with 300 pico-Amperes[2] and 50 MeV for a routine power of 0.015 Watts. The beam will be modulated by the CO2 laser and beam energy will have an energy range of 40-110 MeV after interaction with the laser beam. The laser can only fire once every 30 beam pulses so that the duty factor for the modulated beam is small. The spectrometer magnet can bend 40 MeV electrons 30 degrees when operated at the power supply maximum of 10 amperes.

The initial design of the beam dump was provided in an e-mail by D. Beavis[3]. The design assumes that there are no operating constraints on the beam other than the minimum energy of 30

[1] K. Kusche and M. Fedurin, "Shielding Review for Temporary Spectrometer for RUBICON Experiment, ATF Beamline #2", Jan. 20, 2015.
[2] This is 200 pC at 1.5 Hz.
[3] D. Beavis, E-mail to K. Kusche, Jan 14., 2015.

MeV and a maximum energy[4] of 80 MeV. The beam dump design used information in NCRP Report No. 144 for the radiation generated by x-rays and the ability to shield then with Pb and concrete. Additional shielding and source parameters were used from P.K. Job and W.R. Casey[5]. A maximum beam power of 1.3 Watts was assumed. A dose rate of 0.05 mrem/hr outside of the end walls and side walls was used in the design and 1.7 mrads/hr on the building roof. Personnel are not to be on the building roof during beam operations. The experiment is expected to operate for 3-4 weeks. The beam dump will be documented with pictures and inspection rather than a set of QA1 drawings. This was considered acceptable due to the short duration of the beam dump use. The shielding procedure[6] was modified in the past to accommodate such documentation.

A routine survey will be conducted along with a fault study with the beam bent at the maximum for both magnet polarities. **(CK-ATF-K. Kusche&D. Beavis-934)**
Place dump under configuration control. **(CK-ATF-K. Kusche&D. Beavis-935)**
Document beam dump. **(CK-ATF-K. Kusche&D. Beavis-936)**

Note added after the meeting: The beam dump has been built with a hole a zero degrees to accommodate the experimental detector without making the dump exceedingly large. A small secondary dump 8 inches by 8 inches by 6 inches thick was added downstream of the detector to cover the small hole in the dump. It is a fault condition for the electron beam to be running with the magnet off. This has been added as a fault study condition. In addition, a pumping port on one west side of the beam dump penetrates the Pb shielding. The dump was inspected by K. Kusche and D. Beavis and thought to be acceptable to conduct fault studies. The fault study plan has been reviewed and will be conducted on Jan. 23, 2015.

RHIC Pre-fire Masks

A. Drees lead discussion[7] of the pre-fire abort masks. The committee reviewed the radiation and exposure issues presented in section 3.1 of footnote 7. The number of bunches that are expected to hit a mask during a pre-fire are less than 15. Operational history shows there are about ten pre-fires per year per ring based. The purpose of this review is to ensure that the total lost beam on the masks will not create radiological issues.

An Maximum Credible Incident for beam losses is defined as half the beam in a single ring lost at a local location. The high-beta quads and the primary collimators are locations where an MCI is defined as 100% of the beam in a ring. After some discussion it was agreed that the pre-fire masks are locations where one should expect 100% of the beam can be lost.

The masks have jaws on each side of the beam but only one jaw is planned to be used for pre-fires. The committee did not impose any requirements on the unused jaw but it would be good practice it that jaw was prevented from being operated.

---

[4] The maximum energy is 85 MeV and makes little difference in the dump design. The minimum energy is controlled administratively and it is not expected that much beam below this energy can be transported into the experimental hall.
[5] P.K. Job and W.R. Casey, July 25, 2006, NSLSII Tech. Note 012.
[6] See C-AD OPM 9.1.12 section 5.13.5.
[7] A. Drees et. al., "RHIC Prefire Protection Masks", Jan. 6, 2015.

For one year of operation it is expected that 150 bunches will be lost on a mask. This is approximately 1.5 full beam fills in each ring. Footnote 7 notes that the concentrations of tritium in the soil will be two orders below the BNL action limit after one year of operation. Two removal soil samples will be placed near each mask[8] on the tunnel wall. One soil sample will be sited at approximately 90 degrees from the mask and the other about 12 feet downstream with both near beam height on the outside tunnel wall.[9]

The blue mask will have at least three monitor TLDs placed on the berm to monitor the dose through the berm. It was decide not to place monitor TLDs over the yellow mast since the blue primary collimator will dominate dose out the berm. The TLDs will be placed when they are available and are not required for startup of the machine.
The RSC has approved[10] RHIC operations with a fill per ring up to the equivalent of $3*10^{13}$ protons per ring with beam energy of 255 GeV. The dose on the berm for an MCI event has been given as 130 mrem[11]. This was evaluated for 300 GeV and $5*10^{13}$ protons per ring. **If this number is adjusted for 255 GeV, $3*10^{13}$ protons/ring and 100% beam loss then the result is 140 mrem/hr.** This includes a factor of 1.5 for the dose obtained in MARS verses MCNPX. If this factor is removed then the **MCI dose above the mask is 90 mrem in an MCI.** For a typical location on the berm with 50% beam loss the MCI dose would be 45 mrem. The yellow mask is under a locked-fenced area of the berm due to the blue primary collimator. Personnel are typically not allowed into the area during beam operations except on a case-by-case basis.

The small amount of integrated beam loss renders the issue of off-site exposure due to neutrons as negligible. The shielding was not examined for the amount of soil shielding in the forward direction from the blue mask. Since small angles near 12 O'clock point to the eastern site boundary the potential off-site dose from small angle muons is expected to not be a concern. However, the committee has asked that the berm drawing be examined to determine the distance of soil shielding for small angle muons. The potential dose due to muons can be scaled from previous muon analysis.
(CK-RHIC-Feb. 15, 2015-LP-937)

CC:

Present
RSC
RSC Minutes File
A. Drees

[8] The soil sample near the yellow mask may have levels that are dominated by the blue collimator. However, it was decided to place them for the first year to monitor levels.
[9] M. Van Essendelft and D. Beavis placed the soil samples in the ring after the meeting.
[10] RSC Minutes of April 15&17, 2013; http://www.c-ad.bnl.gov/esfd/RSC/Minutes/4_15.17_13Minutes.pdf
[11] http://www.c-ad.bnl.gov/esfd/RSC/Memos/RHICPROTON_4_19_13.pdf